Ro 261

W. A. CRAIG, INC.

Environmental Contracting and Consulting

6940 Tremont Road
Dixon, California 95620
Contractor and Hazardous Substances License #455752

(707) 693-2929 Fax: (707) 693-2922

FEASIBILITY STUDY/CORRECTIVE ACTION PLAN

PROJECT SITE:
Express Gas & Mart
2951 High Street
Oakland, California 94619

PREPARED FOR:
Mr. Aziz Kandahari
Himalaya Trading Company
2951 High Street
Oakland, California 94619

SUBMITTED TO:
Alameda County Health Care Services
Hazardous Materials Division
1131 Harbor Bay Parkway
Alameda, California 94502

PREPARED BY:
W.A. Craig, Inc.
6940 Tremont Road
Dixon, California 95620

Project No. 3936

July 28, 2003

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

PROFESSIONAL CERTIFICATION

FEASIBILITY STUDY/CORRECTIVE ACTION PLAN

Express Gas & Mart
2951 High Street
Oakland, California 94619

by W.A. Craig, Inc.
Project No. 3936

July 28, 2003

This document has been prepared by the staff of W.A. Craig, Inc. under the supervision of the undersigned licensed professional. No warranty, either expressed or implied, is made as to the professional advice presented in this document. Any data analysis, conclusions, and recommendations contained in this document are based upon site conditions, as they existed at the time of our investigation. Site conditions are subject to change with time, and such changes may invalidate the interpretations and conclusions in this document.

The conclusions presented in this document are professional opinions based solely upon the stated scope of work and the interpretation of available information as described herein. Such information may include third party data that either has not, or could not be verified independently by W.A. Craig, Inc. The reader should note that the scope of services for this project was limited and may not be appropriate to satisfy the needs or requirements of other potential users, including public agencies not directly involved. Any use or reuse of this document or the findings, conclusions, and recommendations presented herein is at the sole risk of said user.

Tim Cook, P.E.
Project Manager

REGISTERED PROFESSIONAL ENGINEER
TIMOTHY D. COOK
No. C054036
Exp. 12-31-03
CIVIL
STATE OF CALIFORNIA

INTRODUCTION

This Feasibility Study/Corrective Action Plan (FS/CAP) was prepared by W.A. Craig, Inc. (WAC) for the Express Gas & Mart, located at 2951 High Street in Oakland, California (the "Site"). The purpose of the FS/CAP is to evaluate potential remedial methods to address fuel-related contamination in soil and shallow groundwater at the Site. The contamination was caused by an accidental release of gasoline from an underground storage tank (UST) system that was replaced in 2001. This FS/CAP was prepared on behalf of the property owner, Mr. Aziz Kandahari. The lead regulatory agency overseeing this case is Alameda County Health Care Services (ACHCS). This FS/CAP has been written to comply with the requirements of the California Code of Regulations Title 23, Division 3, Chapter 16, Article 11.

PHYSICAL SETTING

Site Location

Express Gas & Mart is a self-service gasoline station and convenience store located on the corner of High Street and Penniman Avenue, in southeastern Oakland. The Site location is shown on **Figure 1** and Site features are shown on **Figure 2**. The surrounding area is densely developed. Neighboring properties include commercial and residential developments.

Topography and Drainage

The Site is located about 3½ miles inland from San Francisco Bay. The Site location is near the base of the Oakland Hills, at a surface elevation of about 132 feet above mean sea level (amsl). Hilly topography occurs directly southeast of the Site, a short distance beyond High Street. The ground surface at the Site slopes toward High Street, but the regional topographic slope is southwesterly away from the Oakland Hills. There are no surface water bodies in the Site vicinity.

Geology and Soils

The Site area is located on an alluvial apron that extends northwest-southeast between San Francisco Bay on the west and the northern Diablo Range on the east. The active Hayward Fault forms a structural boundary between the alluvial apron and the Diablo Range. Surficial sediments at the Site have been classified as Holocene-age alluvial fan and fluvial deposits (Helley, E.J. and Graymer, R.W., 1997). These sediments are described as gravelly sand and sandy gravel that grade into sand and silty clay. The nearby hilly areas directly southeast of the Site are underlain by similar, though older, deposits of Pleistocene age.

WAC has recently drilled and sampled soil borings at the Site to install new monitoring wells. Soils encountered in the 25-foot deep borings were predominantly gravelly to sandy silts with some interbedded silt and silty fine sand. Groundwater was positively identified in two of the four borings, at respective depths of 16 feet below grade (fbg) and 4 fbg. The latter boring was drilled offsite, within High Street.

Groundwater

The Site is within the San Francisco Bay regional watershed. The Quaternary alluvial deposits of the region host important aquifers. Slightly less than half the region's water supply is derived from groundwater. The balance is obtained from imported surface water. Confined groundwater is encountered beneath the Site at a depth of approximately 21 fbg. Soils are primarily gravelly sandy silts typical of alluvial fan deposits. Static water levels were 5 to 7 fbg in April 2003 and 7⅓ to 8½ fbg in July 2003. The groundwater flow direction is south-southeast (**Figure 3**). The specific conductivity of groundwater ranged from 620 to 2,000 microsiemens, suggesting that natural water quality is highly variable.

PROJECT BACKGROUND

The history of subsurface contamination investigations at the Site predates WAC's involvement starting in 2001. Groundwater monitoring has been conducted periodically at the Site since early 1995. Groundwater has been impacted by dissolved hydrocarbons, principally in the vicinity of the former USTs. Hydrocarbon constituents include benzene, toluene, ethylbenzene, xylenes (BTEX) and methyl tert-butyl ether (MtBE).

The following information was taken from a groundwater monitoring report dated November 14, 2000 by Aqua Science Engineers, Inc. (ASE). Approximately 2,550 pounds of ORC® slurry was injected into borings along the northern and eastern side of the former USTs in June 1997. The ORC® increased dissolved oxygen (DO) concentrations in five nearby monitoring wells for approximately one year. Hydrocarbon concentrations in well MW-5 were also reduced during that same period. ORC® socks were installed in wells MW-4 and MW-5 in August 1998 after the DO concentrations had declined. The ORC® socks were removed in September 2000 after proving ineffective at reducing dissolved hydrocarbon concentrations.

A Tier 2 Risk-Based Corrective Action (RBCA) analysis was performed in August 1997. The RBCA was conducted by Christopher Palmer, a subcontractor to ASE, to develop site-specific threshold levels (SSTLs) for petroleum hydrocarbons in soil and groundwater. SSTLs for groundwater are listed in **Table 2**. The draft RBCA was reviewed and commented on by ACHCS. Mr. Palmer addressed these comments in the final RBCA and the ACHCS approved the RBCA, including the proposed SSTLs, in a letter dated October 21, 1997.

During upgrades to the fuel dispensers in front of the store, WAC collected eight soil samples from the product line trench on February 28, 2001. High concentrations of petroleum hydrocarbons were detected in all eight soil samples. At the request of ACHCS, WAC prepared a *Site Investigation Workplan* dated March 26, 2001 to conduct a soil and groundwater investigation around the dispenser island. ACHCS approved the workplan and requested that the USTs and contaminated soils be removed and properly disposed.

Six soil borings were drilled and sampled by WAC in late April 2001. Sampling results from the borings confirmed that hydrocarbons were present in soil and groundwater. WAC removed the dispenser pumps, product lines, and four USTs in May 2001. The USTs appeared to be in good condition. However, soil samples from the base and the sides of the UST excavation contained high concentrations of hydrocarbons. WAC excavated contaminated soil from the Site from May 9 to September 27, 2001. Approximately 3,700 tons of petroleum hydrocarbon contaminated soil were removed and disposed at the B&J Class II landfill in Vacaville, California. Two monitoring wells (MW-2 and MW-4) were destroyed during over-excavation activities. The over-excavation area is depicted on **Figure 2**.

Following the completion of soil remediation activities, WAC submitted an *Interim Site Investigation Workplan,* dated February 12, 2002. The workplan proposed to install four new monitoring wells to replace wells that had been previously destroyed and to delineate the extent of dissolved hydrocarbons. The ACHCS approved this workplan in a letter to the owner, dated May 15, 2002. The four wells (MW-7 through MW-10) were installed in March 2003. WAC also resumed quarterly groundwater monitoring in April 2003. MtBE was present in all wells except upgradient well MW-6 in the April 2003 monitoring event (**Table 2**). BTEX was non-detect in all wells except MW-5 and MW-7, which are located on either side of the former USTs. Likewise, these same two wells exceeded the SSTL for MtBE (8,400 μg/L). Benzene was present in MW-5 above the SSTL (200 μg/L). **Figure 4** shows the inferred extent of the MtBE plume as defined by the SSTL.

WAC recommended that corrective actions be implemented to remediate dissolved hydrocarbons to below the SSTLs in the *Quarterly Monitoring and Well Installation Report, First Quarter 2003*, dated July 23, 2003. This FS/CAP was prepared in response to this recommendation. The following section describes remedial options commonly applied at similar sites. Remedial technologies are evaluated based on potential effectiveness in light of hydrogeologic conditions and contaminant distribution at this Site.

REMEDIAL TECHNOLOGY FEASIBILITY EVALUATION

The remedial technology selected for the Site must be capable of reducing dissolved hydrocarbon concentrations in groundwater to below SSTLs. MtBE is the primary constituent of concern and is highly soluble in water. It is also somewhat resistant to treatment by biodegradation and other remediation technologies because it is a large and complex organic compound. The selected remedial option must therefore be highly effective at removing MtBE.

The following table contains a list of remedial technologies widely used at petroleum hydrocarbon-contaminated sites, and the applicability of those technologies in treating various subsurface media.

Remediation Technology	Environmental Media			
	Soil (Vadose Zone)	**Soil** (Capillary Fringe Smear Zone)	**Groundwater**	**Soil Gas**
Bioventing	⊗	○	∅	○
Soil Vapor Extraction	⊗	○	∅	⊗
Excavation	⊗	⊗	∅	∅
Air Sparging	⊗	⊗	⊗	⊗
Ozone Sparging	⊗	⊗	⊗	⊗
In-well O_2 Diffusion (iSOC)	○	⊗	⊗	○
Barrier/Treatment Walls	○	○	⊗	∅
Pump & Treat	∅	∅	⊗	∅

Table Notes:

⊗ Technology generally applicable subject to site-specific conditions.
○ Technology may be applicable but is generally not recommended for this media.
∅ Technology not applicable for the treatment of this media.

A number of the technologies listed in the above table can be eliminated from consideration because they would not control or remediate contamination in groundwater. In addition, technologies that are applicable to groundwater, but not recommended for the treatment of soil at the capillary fringe are also not desirable for use at Express Gas & Mart. Therefore, the following remedial action alternatives will be evaluated below for possible use at the Site:

- Air Sparging with Soil Vapor Extraction;
- In-well Oxygen Diffusion using iSOC™ Technology; and
- Ozone Sparging.

Each of these remedial options should be viable given the hydrogeologic conditions and contaminant distribution at the Site. A discussion of the limitations and advantages of each alternative follows:

Air Sparging with Soil Vapor Extraction

Air sparging (AS) is the process of injecting air under pressure into an aquifer with the objective of forcing the air through the contaminated zone via as many small channels as possible. The basic components of a system include blowers/compressors, piping, and air injection wells. The sparging process causes the volatilization of organic compounds that are susceptible to "stripping" by the flow of air. A soil vapor extraction (SVE) system is installed along with AS in situations where contaminant vapor recovery is necessary (e.g., as required by regulations or in situations where vapor migration could cause adverse impacts). AS is most likely to be successful on contaminants with a high Henry's Law constant, such as benzene (K_H = 0.0054 Atm-m^3/mol). The remediation of compounds with relatively low Henry's Law constants, such as MtBE (K_H = 0.00058 Atm-m^3/mol), typically requires higher airflow rates and a longer duration of AS system operation. Air sparging may also stimulate aerobic biodegradation by the addition of oxygen to the subsurface environment.

One shortcoming of AS is the tendency for injected air to form channels in the aquifer, resulting in very localized and non-uniform remediation of the contaminated zone. Unless site-specific air distribution studies show otherwise, air injection wells should not be more than 15 feet apart. Preferred sites for the application of AS will have sandy or sandy silt soils and target aquifers that are <50 feet deep. Deeper aquifers, fractured treatment zones, highly stratified aquifers, and aquifers composed of soils that become finer with depth are generally more difficult to treat using AS. Air sparging is not expected to be effective in most clayey soils or where the hydraulic conductivity is $<10^{-3}$ cm/sec.

SVE is the process of extracting soil gas from the vadose zone to enhance the volatilization of contaminants that have high vapor pressures such as those found in gasoline. The extracted soil gas and vapor-phase contaminants are then either discharged directly to the atmosphere or, more likely, are first scrubbed through activated carbon and then discharged to the atmosphere. An SVE system typically includes vertical or horizontal wells with long screened intervals that are connected by a manifold to a blower that creates vacuum pressures in the wells. The effectiveness of SVE can be limited in low-permeability soils. SVE by itself is generally not effective at remediating the capillary fringe and saturated zone and should therefore be coupled with AS when those media are a concern.

The following are salient points about AS-SVE:

- Air injection (sparging) would likely promote aerobic biodegradation of certain contaminants by indigenous aerobic bacteria. However, aerobic biodegradation may not be effective on MtBE, which can be recalcitrant to biodegradation.

- VOCs would need to be removed from the extracted soil vapors before venting the vapors to the atmosphere. The most common method for treating organic contaminants in vapors is to use activated carbon, which is less efficient at removing MtBE than BTEX.
- Due to MtBE's high solubility (4-5%) in water and its relatively low Henry's Law Constant, more sparging will be required to effectively remove the dissolved phase MtBE than if BTEX alone were involved.
- Due to the above limitations, the ratio of cost to the mass of hydrocarbons removed will be relatively high compared to the ozone-sparging technology discussed below.

iSOC™ In-Well Oxygen Diffusion Technology

iSOC™ (In-situ Submerged Oxygen Curtain) is a mass transfer process developed by *inVentures Technologies, Inc.* that is designed to deliver super-saturated concentrations of dissolved oxygen (DO) directly into contaminated groundwater. The increased DO stimulates biodegradation of the petroleum hydrocarbons by indigenous microbes. The iSOC™ process is effective at treating dissolved-phase petroleum hydrocarbons as well as sorbed contaminants in the saturated formation, capillary fringe, and smear zone. Unlike conventional sparging, the gas transfer process does not involve air-injection or bubbles, and it reportedly achieves DO concentrations 4 to 10 times greater than other technologies.

The iSOC™ device consists of a stainless steel diffuser 1.62 inches in diameter and 15 inches long. Inside the diffuser are hydrophobic, microporous, hollow fibers that provide a surface area >2,130 ft^2/ft^3 and produce ultra-efficient mass transfer of oxygen to the groundwater. The diffuser is capable of being submerged in a standard 2-inch diameter monitoring well and is typically connected to a standard oxygen cylinder with a pressure regulator. This equipment can be placed inside an oversized wellhead vault set at grade, thus eliminating piping runs and trenching like that required for a sparge system. The super-saturated water inside the iSOC™ well will move out and mix with water in the adjacent aquifer formation. The super-saturated plume of DO will extend out furthest in the downgradient direction. The rate at which DO concentrations decline with distance is dependent, in part, upon the groundwater flow velocity.

A regulated iSOC™ device can infuse over a pound of dissolved oxygen per month at a super-saturated concentration of 70 mg/kg when the diffuser is submerged 20 feet below the water table. A typical oxygen infusion rate is <10 cm^3/minute and so an oxygen cylinder can last for several months before it needs replacing. The achievable DO concentration is dependent upon the height of the water column in a well, and can range from about 42 mg/kg when there is 5 feet of head to over 100 mg/kg for a diffuser submerged under 50 feet of water. The manufacturer states that these DO concentrations will remain stable for several days (assuming no further oxygen inputs or groundwater flow).

The following are salient points about iSOC™:

- iSOC™ is relatively simple, low cost, and low maintenance.
- Installation of iSOC™ would not require trenching to lay piping and so would be less disruptive during construction than other remedial options.
- iSOC™ by itself does not destroy contaminants, but it provides an adequate supply of DO to promote and maintain aerobic biodegradation. This assumes, however, that microbes capable of degrading gasoline and MtBE are already present.
- The rate at which remediation occurs is dependent upon the microbial populations and not the rate of oxygen delivery.

Ozone Sparging

Ozone sparging (OS) is similar to air sparging, but with ozone added to the air injection feed. Ozone (O_3) is a highly reactive oxidizing gas (oxidation potential of 2.07 volts) that will actively breakdown petroleum hydrocarbons and MtBE into carbon dioxide and water. Thus, it is a more aggressive form of treatment than air sparging. In addition, ozone's solubility in water (600 mg/L at 20° C) is two orders of magnitude higher than oxygen, making ozonation much more efficient than ordinary air sparging. Because the contaminants are destroyed in-situ rather than simply transferred to a vapor phase carrier (air), there is no need to use SVE with OS.

WAC has generally used the C-Sparger™ OS system manufactured by KVA, Inc. The KVA system is designed to operate 10 sparge points. The above ground components of the OS remediation system are mounted inside a locked, metal cabinet (the control panel) that ships from KVA as a complete package. The control panel houses an ozone generator, small air compressor, programmable timer, electrical wiring/circuits, and manifold with electromagnetically-actuated solenoids for distributing the pressurized air/ozone mixture to individual sparge points. The ozone generator creates ozone by ionizing oxygen in either ambient air or with the aid of an optional oxygen concentrator. The operating schedule is controlled by a timer that is similar to a Rainbird®. The OS points are operated one at a time for a set number of minutes that the user programs into the timer.

The ozone sparge points are generally similar to an air sparge well, but with several important distinctions. The working portion of an OS point is a 30-inch length of 2-inch diameter, porous PVC casing placed at the bottom of each sparge well. The sparge point section is analogous to a well screen, but has much finer openings (pores). A PVC riser pipe (¾-inch diameter) extends from the sparge point up to the ground surface. Fine-grained sand (#1/20) is placed in the annular space of the borehole around the 30-inch long sparge point. The tiny pores of the sparge point and the fine-grained filter pack combine to help create microbubbles (diameter of 0.3 to

200 microns) that allow the penetration of ozone into fine-grained sediments. The microbubbles have high surface area to volume ratio, which maximizes the oxidative efficiency of the ozone. The annular space above the sand pack is sealed with bentonite and neat cement to prevent the sparge gas from escaping up the annulus.

The OS system can deliver ozone at a flow rate of approximately 3 cubic feet per minute (cfm) at a maximum pressure of 50 pounds per square inch (psi). With the oxygen concentrator installed, approximately 15 grams of ozone per hour can be injected into the subsurface. Case studies have shown that under ideal conditions the ratio of the ozone mass injected to hydrocarbon mass destroyed is approximately 1:1, so the cost to benefit ratio for this technology is relatively low.

OS is generally applicable at any site where air sparging can be conducted. Some of the same limitations also apply to these two technologies. For example, the injected air will tend to form channels in the aquifer, potentially resulting in localized and non-uniform remediation of the contaminated zone. However, as noted above, ozone is far more soluble in water than oxygen, and should therefore have better dispersal outside the air channels. Unless site-specific air distribution studies show otherwise, ozone sparge points should not be more than 15 feet apart.

The following are some additional salient points about OS technology:

- Ozone sparging requires no NPDES or air permits because no groundwater effluent or contaminant-laden vapors are produced. Ozone has a short half-life (~15 minutes) and will not persist in the environment.
- Breakdown of ozone provides an oxygen rich environment, which also promotes aerobic biodegradation of contaminants by indigenous bacteria.
- Ozone sparging will likely achieve remedial action goals in a shorter period than the other technologies evaluated above.
- WAC recently installed an ozone-sparge system at another gas station for a cost of approximately $95,000. Our costs for routine operation and maintenance of that ozone-sparge system have been running around $1,500 per month.

Recommendation

Based on the foregoing discussion about the characteristics of these technologies, we conclude that AS-SVE would be the most expensive of the three remedial options to implement and would be less efficient at contaminant destruction than OS. iSOC™ is appealing for its simplicity and low cost, but would have a less certain outcome than OS. Given the need for expeditious Site remediation, iSOC™ is not recommended. Therefore, WAC recommends that ozone-sparging be implemented to reduce contaminant concentrations to the SSTL cleanup goals. The proposed installation of a remediation system with 10 ozone sparge points is described below.

PROPOSED CORRECTIVE ACTION PLAN

The scope of work for the proposed remedial action will consist of the following tasks:

- Phase 1 – Obtain permits and regulatory approvals for installation and operation of the ozone sparge remediation system;
- Phase 2 – Ozone sparge system construction and startup;
- Phase 3 – Operation of the remediation system and groundwater monitoring;
- Phase 4 – Remediation system shut down; and
- Phase 5 – Quarterly groundwater sampling for two additional quarters to monitor for contaminant rebound.

Phase 1 - Obtain Permits and Regulatory Approvals for Installation and Operation

WAC will obtain the required permits and approvals from regulatory agencies for installing the remediation system. A permit will be obtained from the appropriate agency for the electrical wiring to provide power to operate the system.

Phase 2 – Ozone-Sparge System Construction and Startup

WAC will purchase and install a C-Sparger™ ozone sparge remediation system manufactured by KVA, Inc. Once installed, the system will be operated on a fulltime (24/7) schedule until either contaminant concentrations are reduced to below action levels or until meaningful improvements are no longer evident, which ever condition occurs first. At least one or more years of operation can be expected before an endpoint is reached.

System Design

The OS system will have 10 ozone-sparge points. The OS points will be installed into the confined water-bearing zone at depths ranging between about 25 and 30 fbg, depending on the occurrence of sandy/gravelly layers. Proposed sparge point locations are shown on **Figure 4.** Placement of the OS points will be focused on the area of the former USTs where SSTLs are exceeded. The OS points will be spaced approximately 15 feet apart in order to ensure that there will be an overlap in the radii of influence for adjacent sparge points. However, the actual distribution of influences will be controlled by the heterogeneity and effective porosity of the soil.

The control panel and oxygen concentrator will be protected in a locked, metal cabinet mounted on two 4x4 posts set in concrete. Traffic posts or chainlink fencing will provide additional protection for the control equipment.

Sparge Point Construction

A licensed well driller will be contracted to install the OS points. Construction details for a typical OS point are illustrated on **Figures A1** and **A2** in **Appendix A**. The sparge point borings will be drilled using hollow-stem, continuous flight augers. The borehole diameter will provide at least two-inch annular space between the sparge point and the borehole wall. Prior to drilling each borehole, augers will be cleaned to avoid cross-contamination.

The OS point borings will be logged by a WAC field geologist working under the supervision of a California-registered engineer or geologist. Soil will be classified using the Unified Soil Classification System. Soil will be screened for VOCs using a portable photo-ionization detector (PID). One composite soil sample of the drill cuttings will be analyzed at the laboratory for waste profiling purposes. Soil cuttings will be stored onsite in labeled, 55-gallon drums pending the analytical results.

A traffic-rated well vault set to grade will protect the top of each riser pipe at the surface. Individual supply lines will extend to each sparge point from the ozone generator panel. The lines will be buried 1½ feet deep in trenches. After the lines are laid, the trenches will be backfilled and compacted, and the surface restored to original condition. The buried supply lines will consist of ⅜-inch diameter, flexible polyethylene tubing enclosed within a secondary protective shell of ⅞-inch diameter polyethylene tubing. Teflon™ and PVC fittings will be used within the well vaults to connect the riser pipe of each OS point to its supply line. An in-line check-valve within each vault will prevent back flow out of the sparge point.

Remediation System Start-Up

The system will be closely monitored at initial startup to ensure that it is operating correctly. Staff will observe at least one complete sparge cycle to verify that the timer is functional. The pressure gauge on the manifold will be monitored to ensure that normal operating pressures (20-35 psi) are achieved in each OS point. After the initial system checkout has been completed satisfactorily, a daily schedule will be programmed into the timer and each OS point assigned a set number of minutes to sparge during each cycle (KVA recommends 7 minutes). The total minutes to complete a cycle will determine the number of cycles that can be programmed per 24-hour period. A 10-minute rest period is included at the end of each cycle to allow the dissipation of excess heat produced by the ozone generator and air compressor.

Phase 3 - Operation of the Remediation System and Groundwater Monitoring

The OS system will be operated on a continuous basis. However, periodic shutdowns can be expected in order to service or replace equipment. The continuous operating schedule is hard on some components, and particularly the air compressor, which has a lifespan of about 6-18 months. The air compressor also produces a constant vibration, which can eventually damage other components mounted on the control panel. WAC staff will service and maintain the system on a regular basis in accordance with the manufacturer's recommendations. WAC technicians will visit the Site at least once per week to check pressures and perform maintenance as needed. Couplings and hoses will be inspected for leaks, and loose electrical connections tightened or replaced as needed. Significant service and maintenance events will be noted in the quarterly groundwater monitoring reports.

Quarterly groundwater monitoring will continue to be performed in compliance with current requirements. In addition, during the first two months of system operation the dissolved oxygen concentration will be monitored weekly in all onsite wells, and MW-5, MW-7, MW-8, and MW-9 will be sampled bi-weekly for laboratory analyses of TPH-g, BTEX, and fuel additives. These data will help in determining the optimum operating schedule for the OS points. The optimum schedule should be one that maximizes DO concentrations. The weekly/bi-weekly monitoring data will be included in the next *Quarterly Monitoring Report* following that initial two-month period.

Phase 4 – Remediation System Shut Down

A recommendation to cease operating the remediation system will be submitted under two possible scenarios: (1) when hydrocarbon concentrations in groundwater decrease to below SSTLs, or (2) when hydrocarbon concentrations in Site monitoring wells do not decrease for four consecutive quarters. Over time the rate of hydrocarbon destruction may diminish to the point where there is little or no measurable improvement. At that point in time the cost of remediation will exceed the benefit and a decision must be made to shut down the OS system and either close the Site or evaluate other remedial options.

Phase 5 – Quarterly Groundwater Monitoring for Two Additional Quarters

In order to cease remediation and obtain Site closure, continued quarterly groundwater monitoring will be needed for two additional quarters after the SSTLs are achieved to demonstrate that contaminant rebound does not occur. If contaminant concentrations do not rebound above the SSTLs, then the responsible party will petition for case closure. Once ACHCS approves closure, the monitoring wells and sparge points will be abandoned in accordance with applicable regulations. The ozone generator and control panel will be removed and the site restored to pre-existing conditions.

TABLES

TABLE 1

Monitoring Well Construction Information
2951 High Street, Oakland, California

Well ID	Date Installed	Total Depth (ft)	Screened Interval (ft)	Water-Bearing Unit	Top of Casing Elevation (ft msl)	Northing (ft)	Easting (ft)
MW-1	2/95	25	N/A	N/A	131.64	2,112,552.4	6,070,038.2
MW-3	2/95	25	N/A	N/A	131.05	2,112,539.6	6,070,048.6
MW-5	12/9/96	30	5-30	N/A	131.99	2,112,582.0	6,070,083.6
MW-6	1/7/97	30	5-30	N/A	132.58	2,112,662.5	6,070,113.5
MW-7	3/24/03	25	15-25	gravelly sandy silt	130.93	2,112,533.2	6,070,106.3
MW-8	3/24/03	25	15-25	gravelly sandy silt	131.15	2,112,527.9	6,070,153.7
MW-9	3/25/03	25	15-25	silty gravelly sand	130.00	2,112,484.8	6,070,065.6
MW-10	4/4/03	25	15-25	sandy silt	127.19	2,112,393.3	6,069,984.7

Notes:

All wells are 2-inch diameter casing and screen.

ft msl, feet above mean sea level. N/A = data not available.

Wells surveyed by Virgil Chavez Land Surveying on April 15, 2003.

MW-1, MW-3, MW-5, and MW-6 were installed by Aqua Science Engineers, Inc.

MW-7, MW-8, MW-9, and MW-10 were installed by W.A. Craig, Inc.

TABLE 2
Analytical Results for Groundwater Samples
2951 High Street, Oakland, California

Well ID	Date	TPH-g	benzene	toluene	ethyl-benzene	xylenes	MtBE	DIPE	EtBE	tAME	tBA	methanol	ethanol	EDB	DCA
MW-1	2/23/95	<50	<0.5	<0.5	<0.5	<0.5	NT	NT	NT	NT	NT	NT	NT	NT	NT
	5/26/95	<50	<0.5	<0.5	<0.5	<0.5	NT	NT	NT	NT	NT	NT	NT	NT	NT
	8/23/95	<50	<0.5	<0.5	<0.5	<0.5	NT	NT	NT	NT	NT	NT	NT	NT	NT
	4/4/03	<50	<0.5	<0.5	<0.5	<0.5	270	<5	<5	<5	<50	<5,000	<500	<5	<5
MW-3	2/23/95	<50	<0.5	<0.5	<0.5	<0.5	NT	NT	NT	NT	NT	NT	NT	NT	NT
	5/26/95	<50	<0.5	<0.5	<0.5	<0.5	NT	NT	NT	NT	NT	NT	NT	NT	NT
	8/23/95	<50	<0.5	<0.5	<0.5	<0.5	NT	NT	NT	NT	NT	NT	NT	NT	NT
	4/4/03	<50	<0.5	<0.5	<0.5	<0.5	1,600	<25	<25	<25	<250	<25,000	<2,500	<25	<25
MW-5	12/13/96	3,600	180	**350**	81	**510**	430	NT	NT	NT	NT	NT	NT	NT	NT
	3/27/97	120,000	**28,000**	**16,000**	**2,600**	**10,000**	**64,000**	NT	NT	NT	NT	NT	NT	NT	NT
*	6/27/97	6,300	**10,000**	**2,400**	**290**	**4,500**	**43,000**	NT	NT	NT	NT	NT	NT	NT	NT
	9/22/97	<50,000	7.9	3.3	0.6	3.3	**30,000**	NT	NT	NT	NT	NT	NT	NT	NT
	12/6/97	<5,000	33	12	<5	7.3	**33,000**	NT	NT	NT	NT	NT	NT	NT	NT
	3/23/98	29,000	150	160	130	320	**34,000**	NT	NT	NT	NT	NT	NT	NT	NT
	6/10/98	53,000	**7,000**	**2,400**	**540**	**3,400**	**67,000**	NT	NT	NT	NT	NT	NT	NT	NT
	7/23/98	36,000	**1,000**	**270**	<120	**740**	**51,000**	NT	NT	NT	NT	NT	NT	NT	NT
**	9/16/98	56,000	**3,400**	**1,300**	**430**	**1,800**	**84,000**	NT	NT	NT	NT	NT	NT	NT	NT
	11/23/98	63,000	**5,700**	**2,900**	**500**	**2,200**	**87,000**	NT	NT	NT	NT	NT	NT	NT	NT
	3/5/99	42,000	<250	<250	<250	<250	**38,000**	NT	NT	NT	NT	NT	NT	NT	NT
	6/17/99	37,000	**510**	85	5.6	89	**61,000**	NT	NT	NT	NT	NT	NT	NT	NT
	9/15/99	54,000	**8,500**	**1,800**	**420**	**2,400**	**55,000**	NT	NT	NT	NT	NT	NT	NT	NT
	12/9/99	34,000	**1,600**	230	130	**570**	**33,000**	NT	NT	NT	NT	NT	NT	NT	NT
	3/6/00	21,000	**7,800**	**870**	**440**	**2,100**	**30,000**	NT	NT	NT	NT	NT	NT	NT	NT
	6/7/00	<50,000	**11,000**	**890**	**570**	**3,000**	**68,000**	NT	NT	NT	NT	NT	NT	NT	NT
	9/18/00	40,000	**4,900**	<250	<250	**1,700**	**46,000**	NT	NT	NT	NT	NT	NT	NT	NT
	4/4/03	1,800	**560**	<5.0	<5.0	30	**19,000**	<330	<330	<330	<3,300	<330,000	<33,000	<330	<330

p:\3936 high street\work plans\cap 7-03\tabls.xls

TABLE 2

Analytical Results for Groundwater Samples
2951 High Street, Oakland, California

Well ID	Date	TPH-g	benzene	toluene	ethyl-benzene	xylenes	MtBE	DIPE	EtBE	tAME	tBA	methanol	ethanol	EDB	DCA
MW-6	1/13/97	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	3/27/97	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	6/27/97	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	9/22/97	<50	<0.5	<0.5	<0.5	<0.5	24	NT	NT	NT	NT	NT	NT	NT	NT
	12/6/97	94	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	3/23/98	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	6/10/98	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	7/23/98	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	9/16/98	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	3/5/99	55	<0.5	0.92	0.5	1.3	<5	NT	NT	NT	NT	NT	NT	NT	NT
	6/17/99	<50	<0.5	<0.5	<0.5	<0.5	8.0	NT	NT	NT	NT	NT	NT	NT	NT
	9/15/99	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	12/9/99	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	3/6/00	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	6/7/00	<50	<0.5	<0.5	<0.5	<0.5	<5	NT	NT	NT	NT	NT	NT	NT	NT
	4/4/03	<50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5.0	<500	<50	<0.5	<0.5
MW-7	4/4/03	1,400	54	27	15	180	**26,000**	<500	<500	<500	<5,000	<500,000	<50,000	<500	<500
MW-8	4/4/03	<50	<0.5	<0.5	<0.5	<0.5	230	<5	<5	<5	<50	<5,000	<500	<5	<5
MW-9	4/4/03	<50	<0.5	<0.5	<0.5	<0.5	85	<1.5	<1.5	<1.5	<12	<1,200	<120	<1.5	**2**
MW-10	4/23/03	79	<0.5	<0.5	<0.5	<0.5	1,900	<25	<25	58	<250	<25,000	<2,500	<25	<25
SSTL		**NE**	**200**	**270**	**180**	**470**	**8,400**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

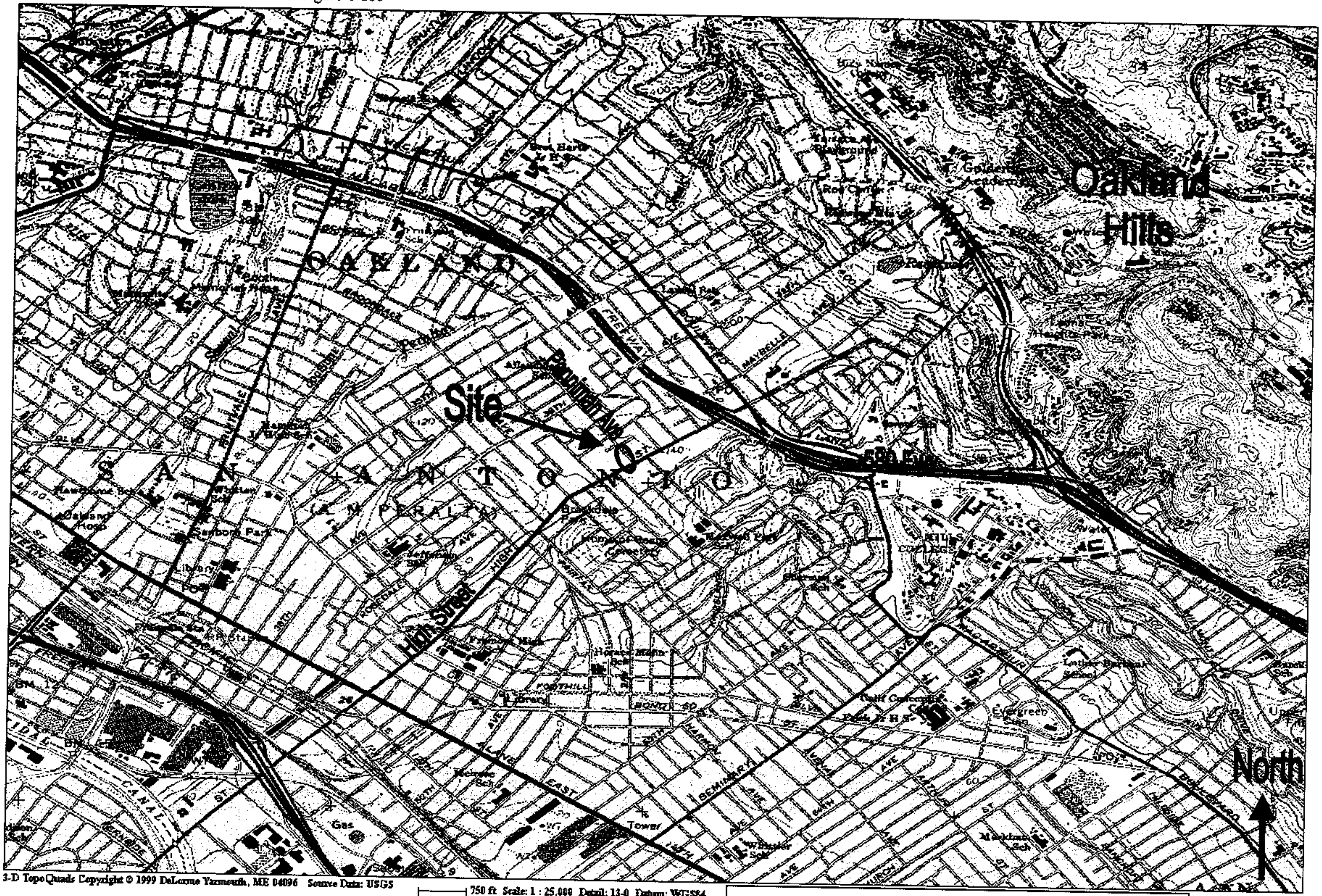
Notes: Concentrations are micrograms per liter (ug/L). **Bold** concentrations exceed the SSTL.
SSTLs are site-specific target levels developed for the site by Aqua Science Engineers, Inc. in 1997.
NE, SSTL not established for this compound. NT, analyte not tested.
Data prior to April 2003 are from *Groundwater Monitoring Report for September 2000 Sampling* by Aqua Science Engineers, Inc. dated 11/14/2000.
* Oxygen Release Compound (ORC) was injected into borings on the south side of MW-5 in late June 1997.
** ORC socks were placed in MW-5 in August 1998 and removed in September 2000.

TPH-g	Total Petroleum Hydrocarbons as gasoline	tAME	tert-Amyl Methyl Ether
MtBE	Methyl tert-Butyl Ether	tBA	tert-Butanol
DIPE	Di-isopropyl Ether	EDB	Ethylene Dibromide
EtBE	Ethyl tert-Butyl Ether	DCA	1,2-Dichloroethane

p:\3936 high street\work plans\cap 7-03\tabls.xls

FIGURES

P:\3936 High Street\Work Plans\CAP 7-03\Figure-1.doc



Base map is the Oakland East 7.5-minute quad (USGS, 1980).

W. A. CRAIG, INC.

Environmental Contracting and Consulting

6940 Tremont Road

Dixon, California 95620

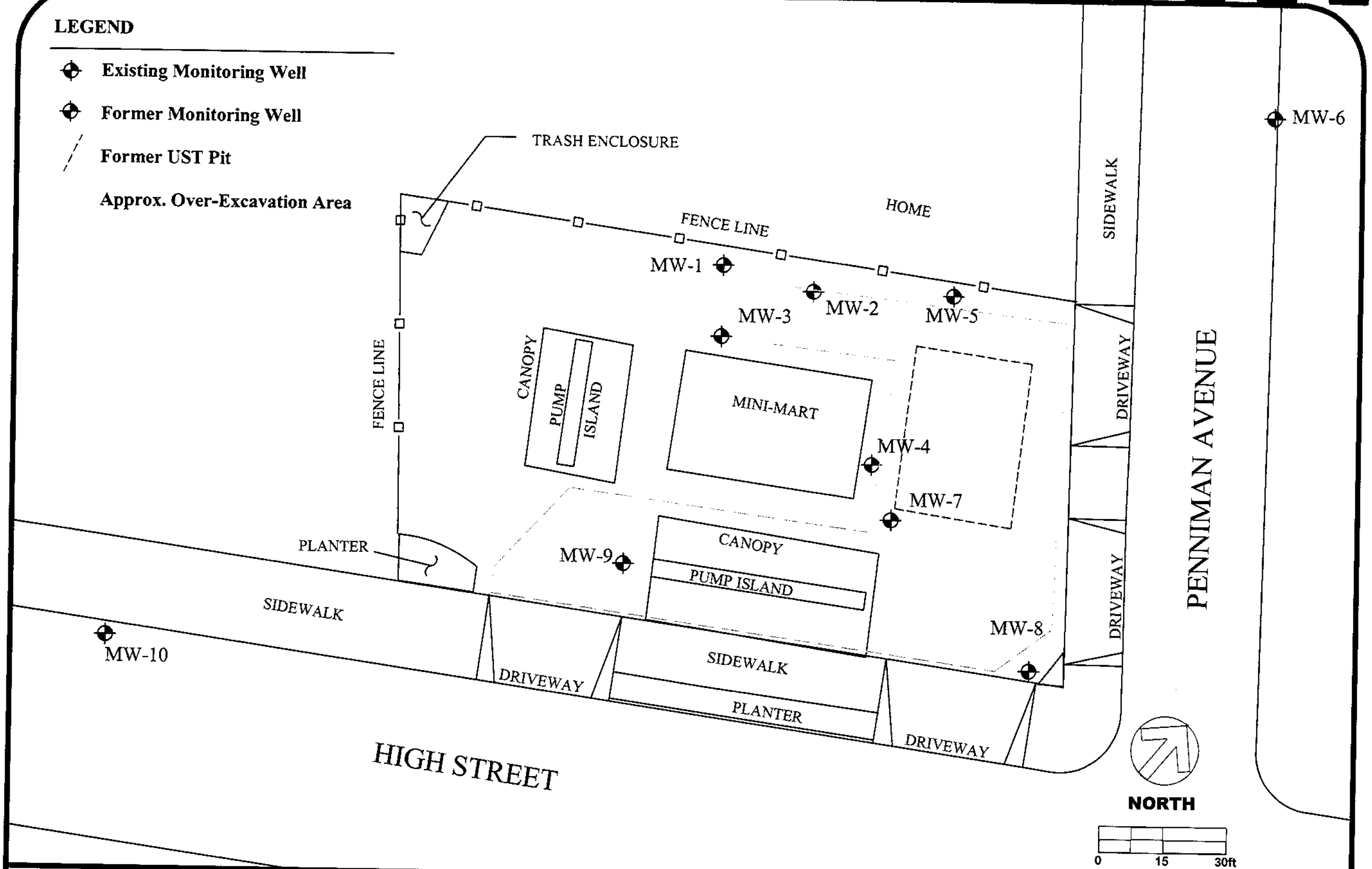
LOCATION MAP

Express Gas & Mart

2951 High Street, Oakland, California

FIGURE 1

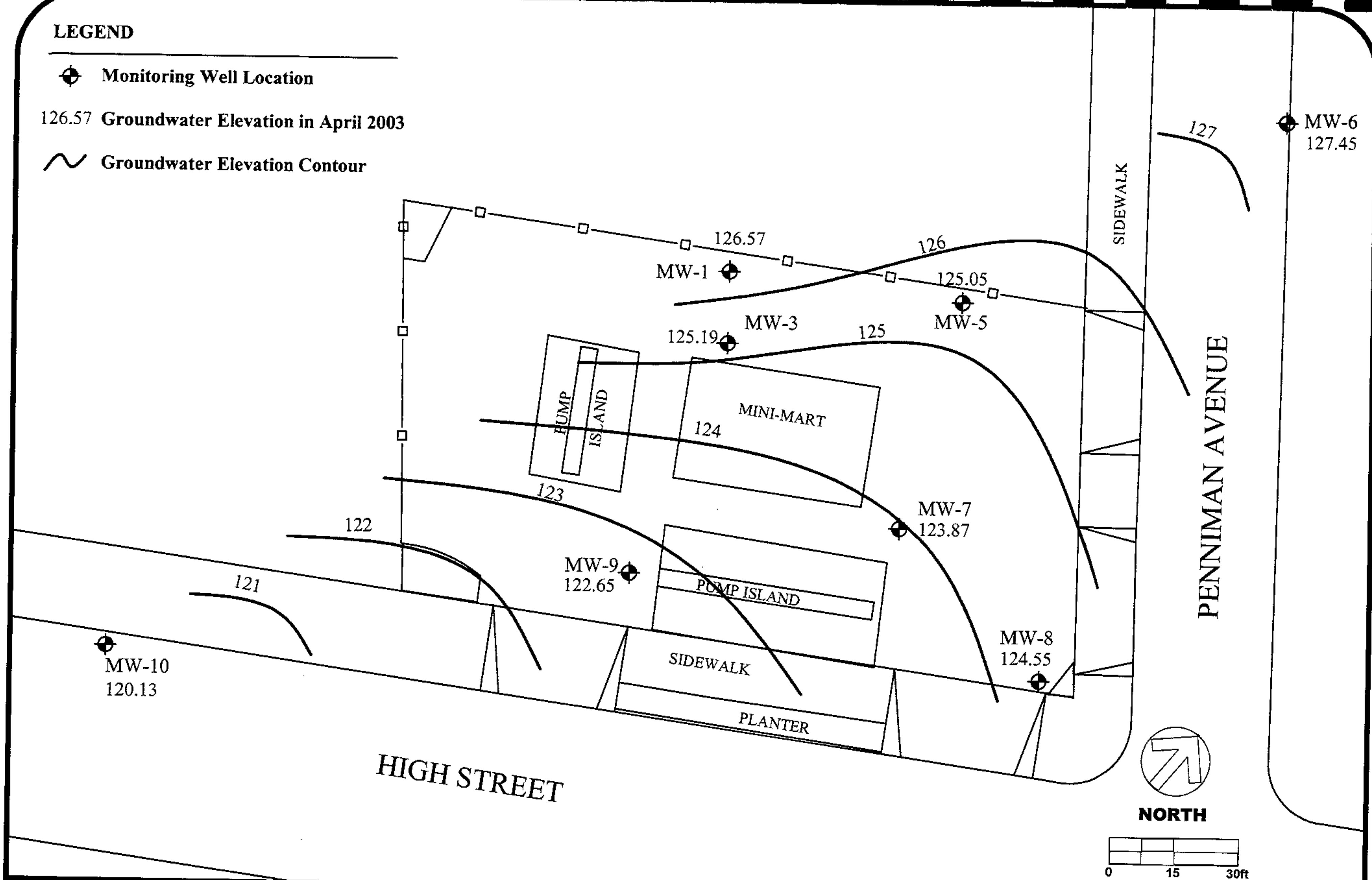
Job No. 3936



W.A. Craig, Inc.
6940 Tremont Road LIC# 455752
Dixon, California 95620-9603
PH# (707) 693-2929 Fax# (707) 693-2922

Site Plan
Express Gas & Mart
2951 High Street
Oakland, California

Project #: 3936	Figure: 2
Date: 7/18/03	
Scale: 1"=30'	



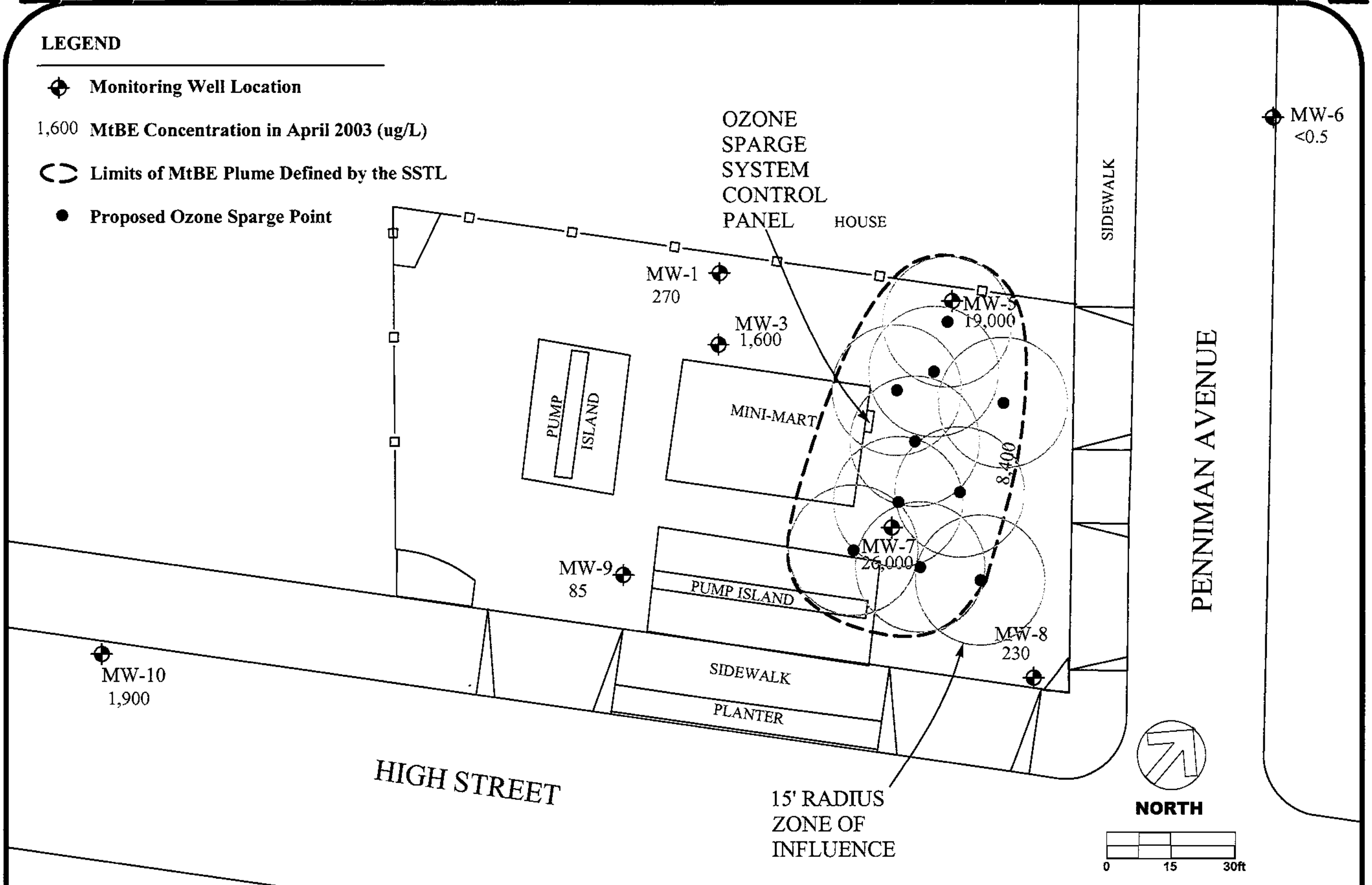
W.A. Craig, Inc.

6940 Tremont Road LIC# 455752
Dixon, California 95620-9603
PH# (707) 693-2929 Fax# (707) 693-2922

Groundwater Elevations

Express Gas & Mart
2951 High Street
Oakland, California

Project #: 3936	Figure: 3
Date: 7/23/03	
Scale: 1"=30'	



Proposed Ozone Sparge System Layout

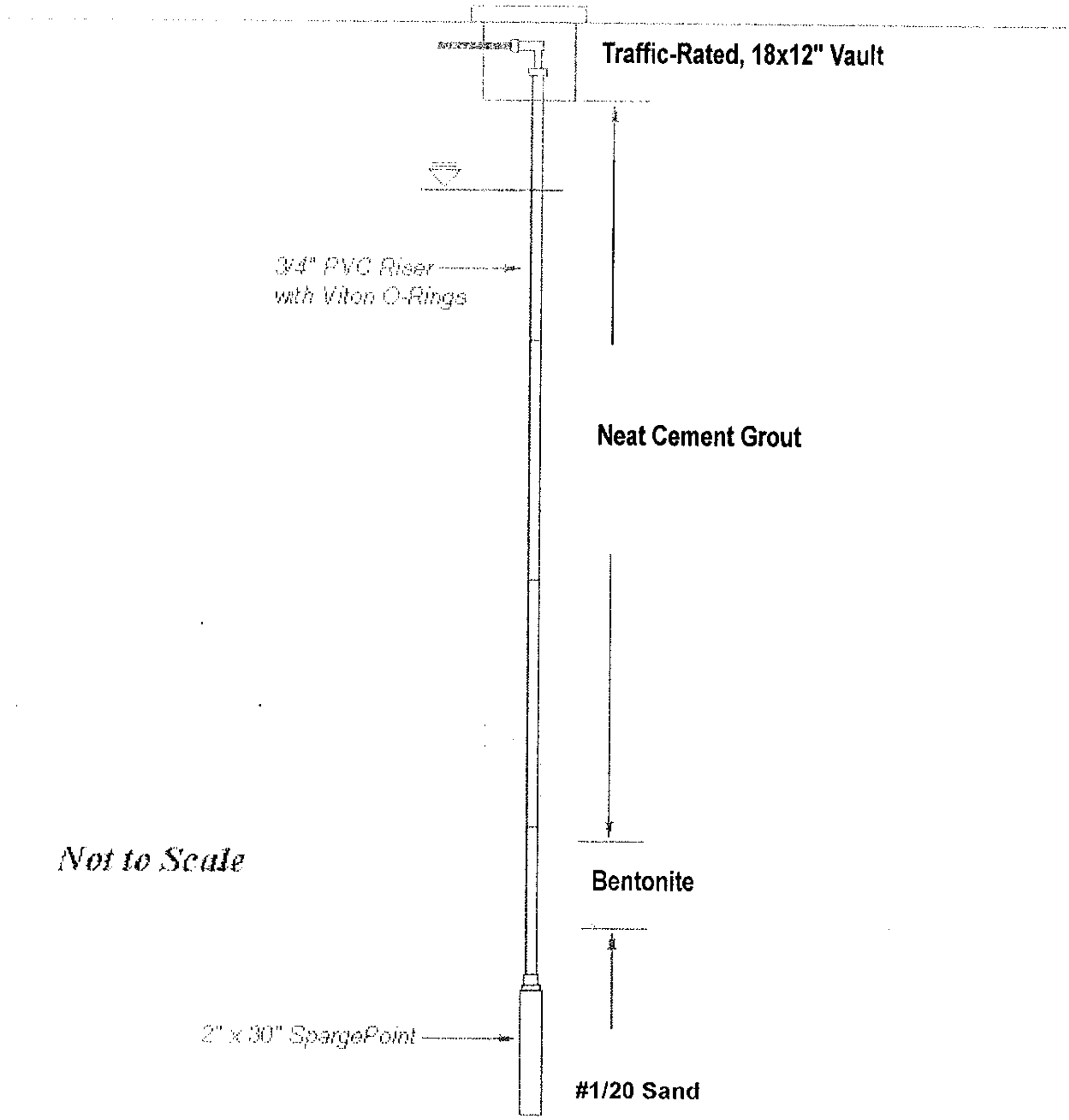
Express Gas & Mart
2951 High Street
Oakland, California

W.A. Craig, Inc.
6940 Tremont Road LIC# 455752
Dixon, California 95620-9603
PH# (707) 693-2929 Fax# (707) 693-2922

Project #: 3936	Figure: 4
Date: 7/23/03	
Scale: 1"=30'	

APPENDIX A

TYPICAL OZONE SPARGE POINT DESIGN



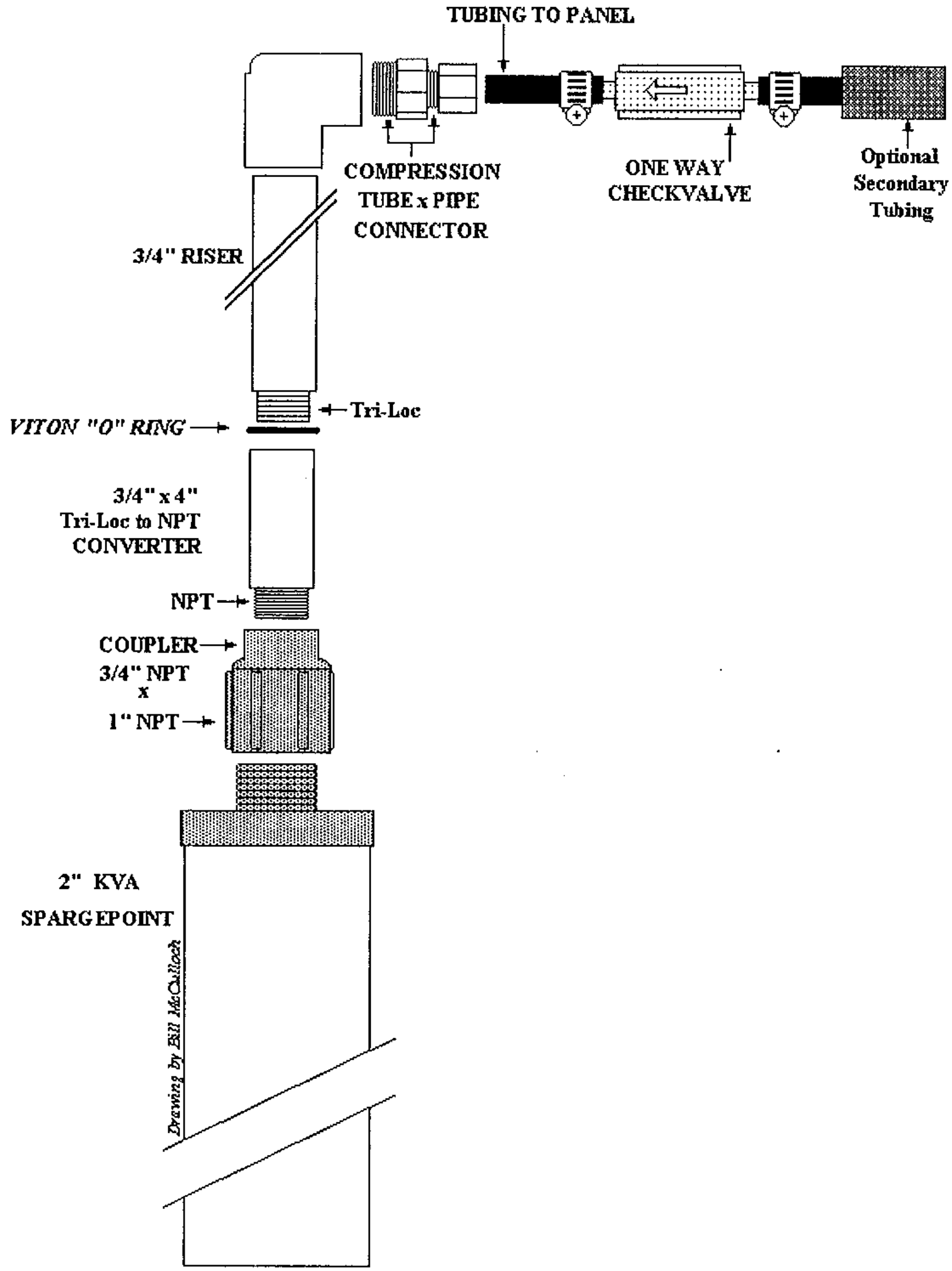
TYPICAL OZONE SPARGE POINT DESIGN

2951 High Street
Oakland, California

Project No. 3936

Figure A1

W. A. Craig, Inc.
Environmental Contracting and Consulting
6940 Tremont Road
Dixon, California 95620
Cal License #455752
(707) 693-2929
FAX (707) 693-2922



TYPICAL SPARGE POINT WELLHEAD DESIGN

2951 High Street
Oakland, California

Project No. 3936

Figure A2

W. A. Craig, Inc.
Environmental Contracting and Consulting
6940 Tremont Road
Dixon, California 95620
Cal License #455752
(707) 693-2929
FAX (707) 693-2922